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(54) **INJECTION MOLDING METHOD AND DEVICE**

(57) An injection molding method and device, wherein, in order to minimize dimension errors of molded products, molten resin is injected from a nozzle (23) retaining therein pre-pressurized molten resin such as plastic into the cavity (3) via an annular gate (24).

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Description

TECHNICAL FIELD

[0001] This invention relates to improvement of injection molding methods and apparatuses which inject molten synthetic resin such as plastic into a closed mold and later open the mold and extract the cooled/solidified molded product to obtain the desired molded product.

BACKGROUND ART

[0002] Over the years, various injection molding methods and apparatuses have been provided as methods and apparatuses for obtaining molded products with comparatively high precision from synthetic resins such as plastic.

[0003] In particular, among the above-mentioned injection molding methods and apparatuses, in recent years injection molding method and device have been proposed for reducing the molding cycle time for molded products.

[0004] This conventional injection molding method or apparatus comprises a nozzle for temporarily holding pre-pressurized molten resin and a valve pin positioned inside the nozzle such that it can be freely inserted or withdrawn. A gate is opened by means of this valve pin to fill the cavity inside the mold with the pre-pressurized molten resin and, after completion of filling the cavity with molten resin, the gate is again closed by means of the valve pin.

[0005] To obtain relatively large molded products, conventionally, a plurality of valves having the above-mentioned valve pins are arranged to face the cavity in the mold, and molten resin is injected simultaneously from each gate of the plurality of nozzles into the cavity to fill it.

[0006] According to this kind of injection molding method and device, during the time the mold is opened to take out the molded product, the molten resin in the nozzle is pre-compressed. Therefore, the wasted time required for compressing the molten resin until injection is reduced and, as a result, there is the effect that the molding cycle time is shortened.

[0007] Figure 8 is a cross-section diagram outlining the main parts of the above-mentioned injection molding apparatus 1, and particularly showing injection molding apparatus 1 for molding disk-shaped parts having a bearing hole in their centers (for example, molded products such as gears.)

[0008] The injection molding apparatus 1 comprises upper mold 2 in which is provided valve main units (not shown in the figure) that pre-compress the molten resin and lower mold 4 in which disk-shaped cavity 3 is formed. Of these upper and lower molds, a plurality of nozzles 5 are provided in specified locations within upper mold 2.

[0009] In addition, the configuration is such that a plurality of gates 6, each consisting of a circular hole, is penetratingly formed at the bottom end of each of nozzles 5 and in the upper surface 3a of cavity 3, corresponding to the plurality of nozzles 5, and disk-shaped cavity 3 is filled with molten resin from the plurality of gates 6 simultaneously.

[0010] Also, inside of each of these nozzles 5, valve pin 7 is arranged facing gate 6 such that it can be inserted and withdrawn in the vertical direction, and so that the downward movement of the valve pin 7 closes gate 6 and thus stops the injection of molten resin into cavity 3 (so called "gate cut").

[0011] In the center of cavity 3 of lower mold 4, cylinder-shaped core 8 is positioned to form the central hole of the disk-shaped molded product that is formed by the molten resin which fills the mold. Ejector pins 9 are provided around the core 8 so as to be freely movable upward/downward relative to core 8, for removing the cooled/solidified molded product from cavity 3.

[0012] Next will be explained the operation of the above conventional injection molding apparatus 1.

[0013] Due to the upwardly retracted position of valve pin 7 as shown in Figure 8, gate 6 is in the open state. Thus, the molten resin which was compressed inside the main body of the valve (not shown in the figure) is injected into cavity 3 via each of the gates 6 of the plurality of nozzles 5 as shown by the. arrows.

[0014] At this time, as in Figure 9 which shows a schematic cross sectional view taken at A-A of Figure 8, molten resin is injected concentrically into cavity 3 from each of the plurality of gates 6 positioned at different locations, as shown by the arrows. These injected molten resins collide and mix so that the cavity 3 becomes filled.

[0015] When, the molten resin is injected into cavity 3 via the plurality of gates 6 in this way and filling is completed, valves 7 move downward as shown by the arrows in Figure 10 and each gate 6 closes. As a result, injection of molten resin into cavity 3 is stopped (so-called "gate cut").

[0016] Afterward, using cooling means not shown in the figure, the molten resin with which cavity 3 has been filled is cooled and solidified.

[0017] After the molten resin filling cavity 3 is solidified in this way, the mold is opened by separating the upper mold 2 and lower mold 4, and disk-shaped molded product 10 of solidified molten resin remains in cavity 3 of lower mold 4.

[0018] Afterward, when each of the plurality of ejector pins 9 is moved upward parallel to core 8 as shown in Figure 11, disk-shaped molded product 10 is extracted from cavity 3 of lower mold 4, while its lower face is supported by ejector pins 9.

[0019] With this kind of conventional injection molding apparatus 1, as revealed in Figure 12 which shows an elevation view of molded product 10 and Figure 13 which shows a plan view of molded product 10, molded product 10 (for example, a flat gear) is integrally formed

into a disk shape with bearing hole 10A in its center.

[0020] However, with the above-mentioned conventional injection molding method and device 1, as shown in Figure 9, molten resin is injected in cavity 3 in a concentric manner as shown by the respective arrows from each of the plurality of gates 6 positioned in different locations. The cavity 3 is filled as the molted resin collides and mixes within each injection from respective gates 6, but the molten resin injected from different gates 6 does not mix each other under uniform melt conditions in cavity 3. As a result, there is a danger that molten resin boundary regions will be generated in cavity 3 by the molten resin injected from each of the plurality of gates 6 positioned in different locations.

[0021] If such molten resin boundary regions are generated in cavity 3 by the molten resin injected from the plurality of gates 6 positioned in different locations, then, as shown in the elevation view of Figure 12 and the plan view of Figure 13, shrinkage action begins at each boundary region in the molded product the is extracted after being cooled and solidified. Due to the shrinkage action, deformed areas 10b and 10c, or so-called "sinks", occur on the surface, etc. of molded product 10. This can be a major cause of dimension errors in molded product 10.

[0022] Since molded products in which sinks occurred must be re-processed for dimensional correction, there is the defect that manufacturing cost of molded products becomes extremely high.

[0023] With the foregoing in view, an object of the present invention is to provide an injection molding method and device which reduce the dimension errors of molded products as much as possible.

DISCLOSURE OF THE INVENTION

[0024] To solve the above-mentioned defect, the present invention is an injection molding method wherein molded products of synthetic resin are obtained by injecting pre-pressurized molten resin such as plastic from molten resin storing nozzles into a mold cavity via a gate and cooling and solidifying the molten resin injected into the cavity, characterized in that the gate is formed in an annular shape and molten resin is injected into the cavity via the annular gate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Figure 1 is a schematic cross section view of injection molding apparatus which embodies the injection molding method of the present invention;

Figure 2 is a plan view of the runner which guides the molten resin;

Figure 3 shows the injection state of the molten resin inside the cavity;

Figure 4 is a schematic cross section view showing operation of the injection molding apparatus of the present invention;

Figure 5 is a schematic cross section view showing operation of the injection molding apparatus of the present invention;

Figure 6 is an elevation view of a molded product obtained from the injection molding apparatus of the present invention;

Figure 7 is a plan view of a molded product obtained from the injection molding apparatus of the present invention;

Figure 8 is a schematic cross section view of a conventional injection molding apparatus;

Figure 9 shows the injection state of the molten resin inside the cavity of the conventional injection molding apparatus;

Figure 10 is a schematic cross section view showing operation of the conventional injection molding apparatus;

Figure 11 is a schematic cross section view showing operation of the conventional injection molding apparatus;

Figure 12 is an elevation view of a molded product obtained from the conventional injection molding apparatus; and

Figure 13 is an elevation view of a molded product obtained from the conventional injection molding apparatus.

BEST MODE FOR CARRYING OUT THE INVENTION

[0026] One embodiment of the injection molding method and device according to the present invention is described in detail below.

[0027] Figure 1 is a schematic cross section view of injection molding apparatus 20 for implementing the injection molding method of the present invention. The components that are the same as in Figure 8 are identified with the same reference numbers.

[0028] This injection molding apparatus 20 (below, simply "apparatus") also comprises upper mold 21 and lower mold 22. However, in upper mold 21, only one nozzle 23 is provided for injecting molten resin.

[0029] The nozzle 23 is formed in an annular shape (in the embodiment, a cylinder shape) which surrounds core 23 concentrically.

[0030] In the bottom end of this one nozzle 23 which is formed in an annular shape, an annular gate 24 (in the embodiment, circular) is formed which surrounds core 8 concentrically, in the same way as nozzle 23. The diameter of the gate 24 is formed slightly smaller than the diameter of nozzle 23. The gate width S of the annular gate 24 is extremely narrow. In the embodiment, it is set to the order of 0.14- 0.16 millimeters.

[0031] On the other hand, a manifold 25 is provided in upper mold 21 to supply thermally molten resin thereto, and communication between its lower end and annular nozzle 23 is accomplished via a runner 26 which

guides the molten resin.

[0032] As in Figure 2, which shows a B-B cross section of Figure 1, runner 26 comprises three circular arc channels (first arc channel 26a, second arc channel 26b, and third arc channel 26c) which partially surround the outer perimeter of annular nozzle 23.

[0033] The channel lengths of first and third arc channels 26b and 26c are set to be the same.

[0034] On the outer perimeter surface of annular nozzle 23, resin injection ports 23a, 23b, 23c and 23d are formed at a'spacing of every 90° along the circumferential direction thereof,.

[0035] Of these, each of the adjacent resin introduction ports 23a and 23b communicates with the corresponding end of second arc channel 26b, while each of the adjacent resin introduction ports 23c and 23d communicates with the corresponding end of third arc channel 26c.

[0036] In addition, the central part of each of abovementioned second and third arc channels 26b and 26c communicates with the corresponding end of first arc channel 26a that has the longest channel length in runner 26.

[0037] Using runner 26 formed in this way, the length of each channel which delivers molten resin from manifold 25 to each of the four resin injection holes 23a, 23b, 23c and 23d is the same. As a result, various parameters (such as temperature, volume, viscosity) of the molten resin which flows from manifold 25 to the interior of the each of the resin injection holes 23a, 23b, 23c, 23d will be the same. Thus, the molten resin from each of the resin injection holes 23a, 23b, 23c, 23d will flow uniformly into annular nozzle 23 under the same conditions,.

[0038] Next will be explained the operation of abovementioned injection molding apparatus 20 according to the present invention and at the same time the configuration will be explained in more detail.

[0039] As shown in Figure 1, if molten resin compressed in the valve main body (not shown in the figures) is sent under pressure within manifold 25, that molten resin will travel, as shown by the arrows in Figure 2, via runner 16, comprising three arc channels (first arc channel 26a, second arc channel 26b, and third arc channel 26c), and be injected under the same conditions into each of the resin injection holes 23a, 23b, 23c, 23d of annular nozzle 23.

[0040] On the other hand, when the molten resin from each of the resin injection holes 23a, 23b, 23c, 23d, under the same conditions, is injected into annular nozzle 23 and fills it, that molten resin is injected simultaneously into cavity 3 through annular (circular) gate 24 shown in Figure 1.

[0041] At that time, as in Figure 3 which shows a schematic cross section view at C-C of Figure 1, inside cavity 3, the molten resin from the single gate 24 which is formed in an annular shape is concentrically injected (as shown by the arrows) simultaneously toward the outer perimeter face 3a and the inner perimeter face 3b of cavity 3, while maintaining uniform and identical molten conditions, and fills the cavity.

[0042] Consequently, the molten resin injected from the single gate 24, that is formed in an annular shape as shown in Fig. 3, concentrically and towards the outer perimeter face 3a and the inner perimeter face 3b of cavity 3 as shown by the arrows is mixed in the uniform and identical molten state, and therefore the risk of generation of boundary regions inside cavity 3 is reduced remarkably.

[0043] After molten resin from the single gate 24 which is formed in an annular shape is injected into cavity 3 and filling is completed as shown in Figure 4, the pre-pressurization of the molten resin in nozzle 23 by means of valve main body (not shown in the figure) is released.

[0044] On the other hand, because the gate width S of the annular gate 24, as mentioned above, is set to be extremely narrow (in this embodiment, on the order of 0.14 - 0.16 millimeters), none of the no longer pre-pressurized molten resin will leak anew from there (from annular gate 24) into cavity 3. Consequently, in the embodiment, simply by releasing the pre-pressurization of the molten resin, injection of molten resin into cavity 3 can be stopped (so-called "gate cut").

[0045] Afterward, using cooling means not shown in the figure, the molten resin which filled cavity 3 is cooled and solidified.

[0046] In this way, the molten resin which filled cavity 3 is solidified and the result is that disk-shaped molded product 30 of solidified molten resin remains in cavity 3.

[0047] Afterward when the mold is opened by separating upper mold 21 from lower mold 22, and the plurality of ejector pins 9 is raised parallel to core 8 as shown in Figure 5, disk-shaped molded product 30 can be extracted from cavity 3 of lower mold 4, while its lower face is supported by ejector pins 9.

[0048] With molded products 30 obtained from this injection molding apparatus 20, as shown in the elevation view of Figure 6 and the plan view of Figure 7, a disk-shaped molded product 30 (for example a flat gear, etc.) with bearing hole 30a formed in its center is integrally molded.

[0049] On the other hand, the molded product 30, which is removed from the cavity 3 following cooling and solidification, is obtained by mixing the molten resin injected into cavity 3 from annular gate 24 shown in Figure 3 under uniform environmental conditions without producing any boundary regions. As a result, non-uniform molding shrinkage action, which starts at each boundary region during cooling/solidification, is prevented as much as possible, and thus deformations such as so-called "sinks", which occur on the surface, etc. of molded product 30, are prevented. Consequently, injection molded products 30 with extremely high dimensional precision can be obtained.

[0050] In the above-mentioned embodiment annular

nozzle 23 is formed in a cylinder shape and annular gate 24 is circularly shaped. However, the present invention is not limited to the above embodiment. The shapes of nozzle 23 and gate 24 simply need to be annular in shape. Thus, the shape of these components can correspond to the shape of the molded product and therefore it may be square, triangular or etc. There is no limitation on the shape of these components.

[0051] In the above embodiment, as an example of a molded product formed by means of the injection method and apparatus of the present invention, disk-shaped molded product 30 with a bearing hole formed in its center was used. However, of course, the molded products molded according to the injection method and apparatus of the present invention need not be limited to disk-shaped molded product 30, but a square or triangle, etc. in the planar view would also be acceptable. There is no limitation on the shape of the molded products.

[0052] Consequently, the present invention can be applied to all molded products molded from synthetic resin, such as compact disks (CD's), various kinds of gears, floppy disk cases, cassette reels for audio cassettes, etc.

[0053] As explained above, through the injection molding method and device of this invention, molten resin is injected into a cavity from an annular gate, and thus the molten resin is mixed inside the cavity under uniform melt conditions. Because no molten resin boundary regions are generated in the cavity, during cooling and solidifying of the molten resin, non-uniform molding shrinkage action, which starts at each boundary region during cooling and solidifying, is prevented as much as possible. As a result, deformations such as so-called "sinks", which occur on the surface, etc. of molded products, are prevented and injection molded products with extremely high dimensional precision can be provided.

INDUSTRIAL APPLICABILITY

[0054] As explained above, the injection molding method and device of the present invention are suitable for reducing as much as possible dimension errors in molded products.

Claims

1. A method for injection molding in which molten resin is injected from a nozzle which stores pre-pressurized molten resin such as plastic into a cavity of a mold via a gate and the molten resin injected into the cavity is cooled and solidified whereby a molded product of synthetic resin is obtained, wherein
   the gate is formed in an annular shape, and the molten resin is injected from the annular gate into the cavity.

2. A method for injection molding in which molten resin is injected from a nozzle which stores pre-pressurized molten resin such as plastic into a cavity of a mold via a gate and the molten resin injected into the cavity is cooled and solidified whereby a molded product of synthetic resin is obtained, wherein
   the nozzle is formed in an annular shape, the gate is formed in an annular shape and provided at the bottom end of the nozzle, and the molten resin is injected from the annular gate into the cavity.

3. An apparatus for injection molding in which molten resin is injected from a nozzle which stores pre-pressurized molten resin such as plastic into a cavity of a mold via a gate and the molten resin injected into the cavity is cooled and solidified whereby a molded product of synthetic resin is obtained, wherein
   the gate is formed in an annular shape.

4. An apparatus for injection molding in which molten resin is injected from a nozzle which stores pre-pressurized molten resin such as plastic into a cavity of a mold via a gate and the molten resin injected into the cavity is cooled and solidified whereby a molded product of synthetic resin is obtained, wherein
   the nozzle is formed in an annular shape, and the gate is formed in an annular shape and provided at the bottom end of the nozzle.

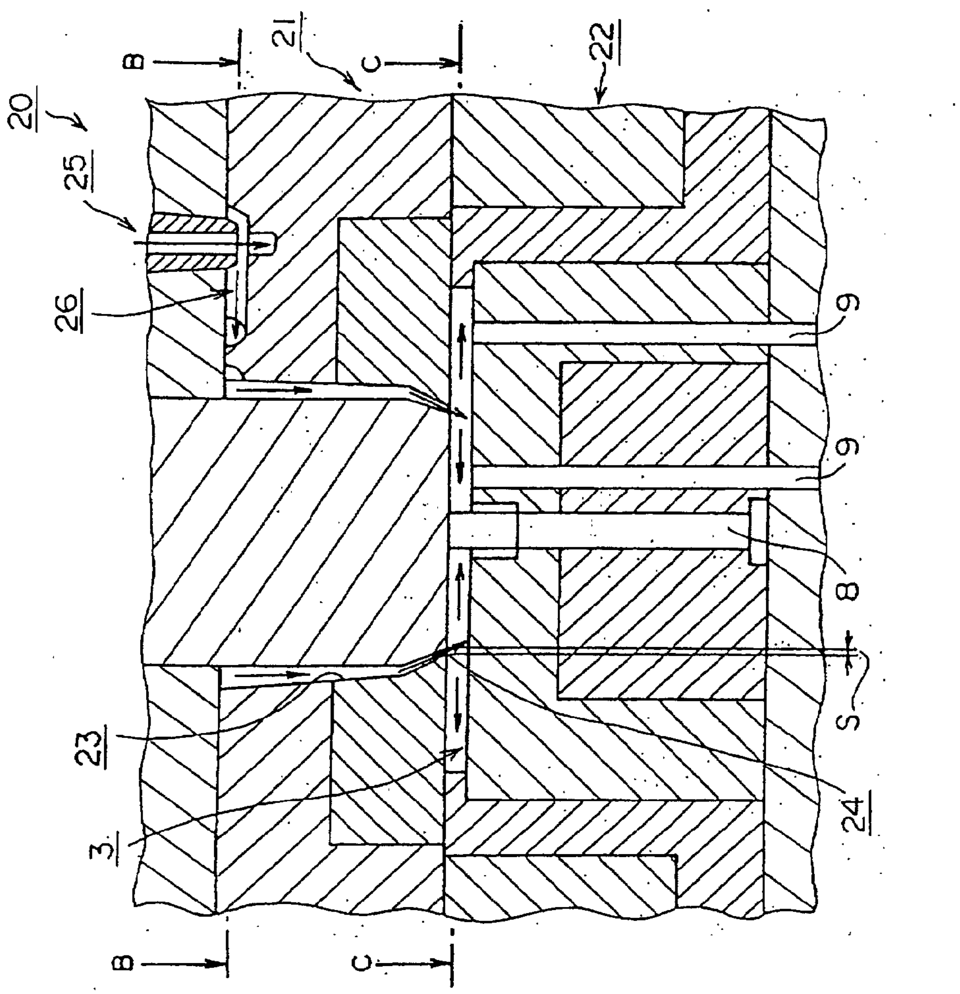

FIG. 1

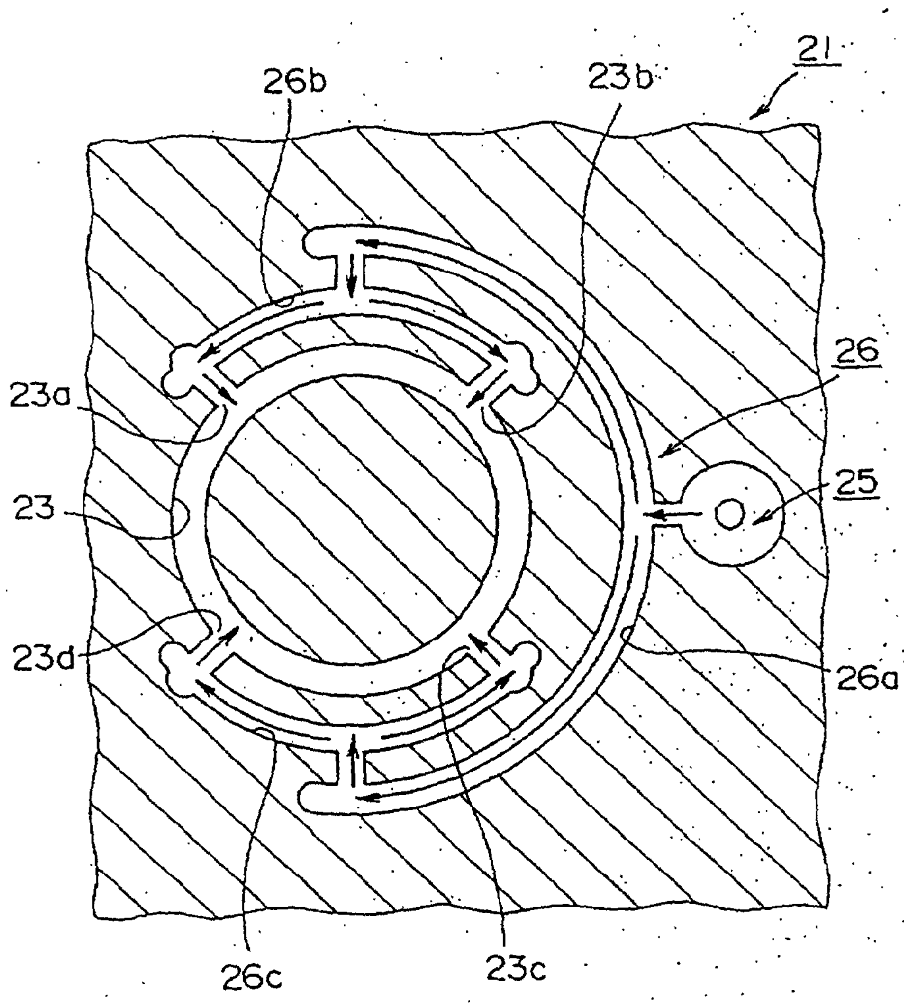

FIG. 2

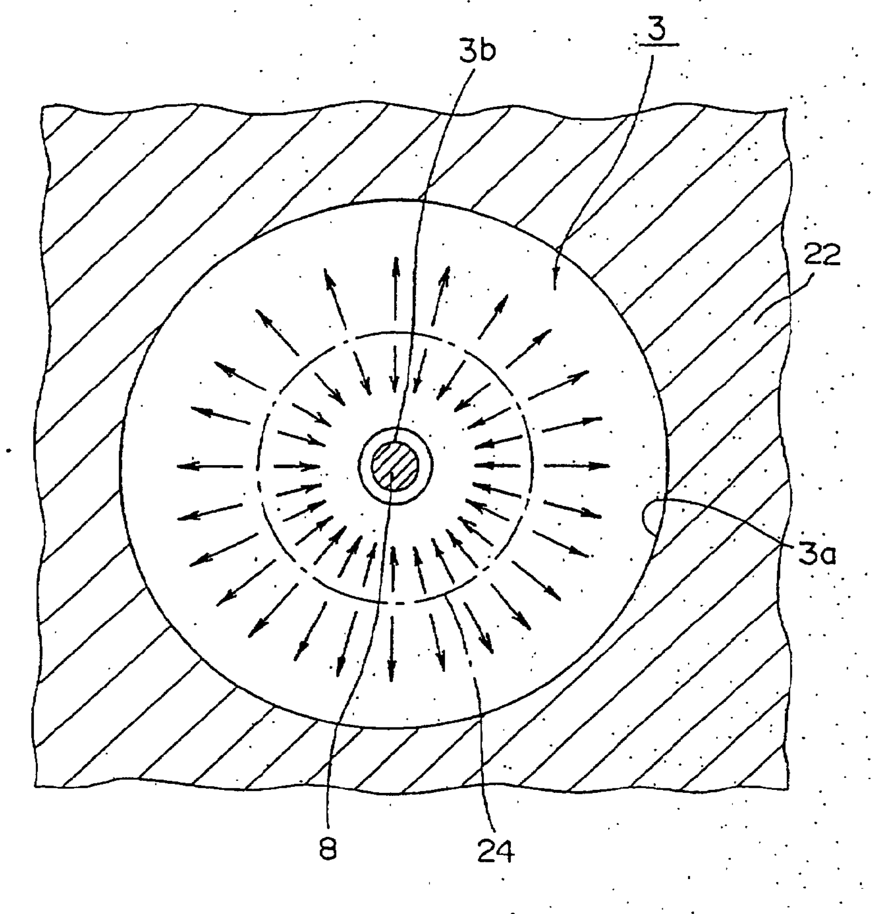

FIG. 3

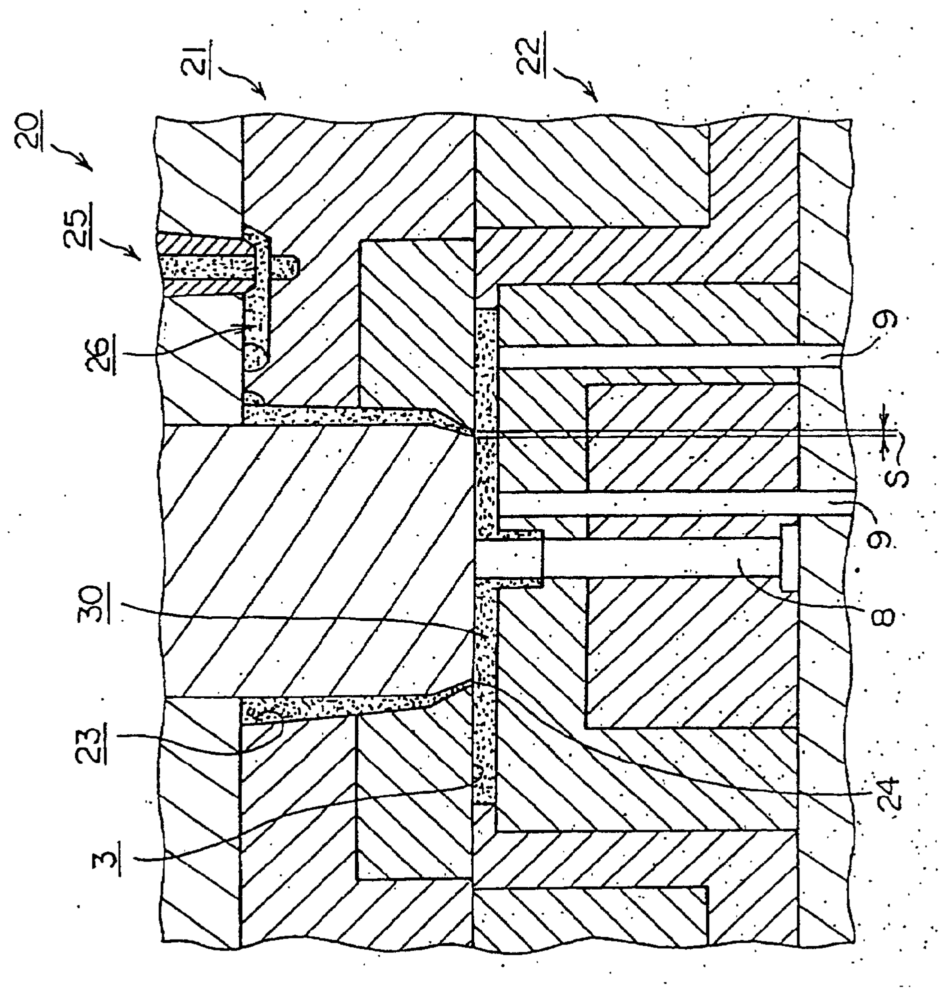

FIG. 4

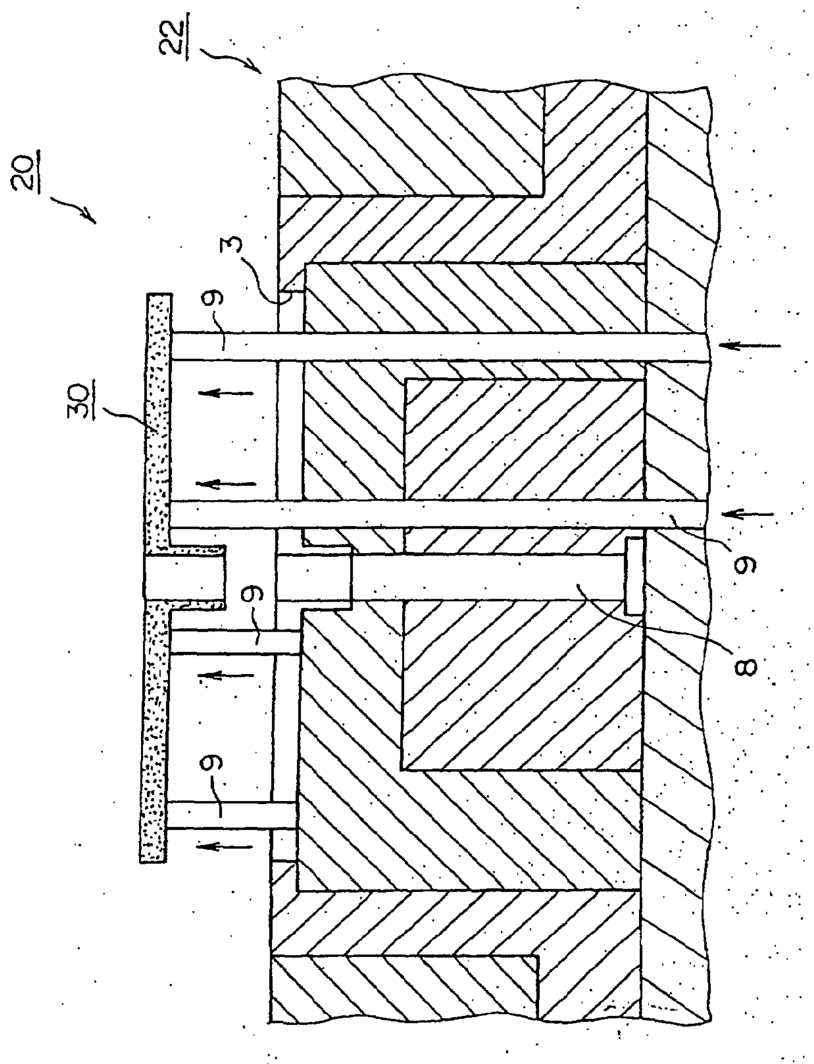

FIG. 5

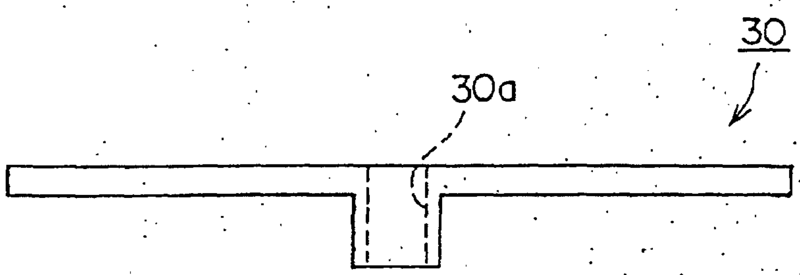

FIG. 6

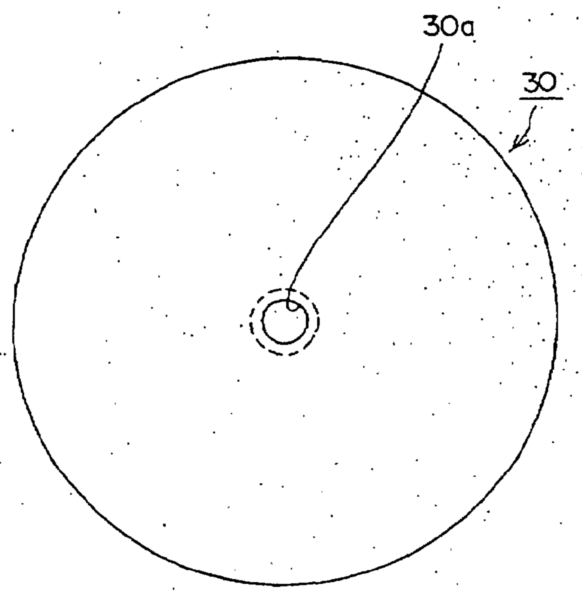

FIG.7

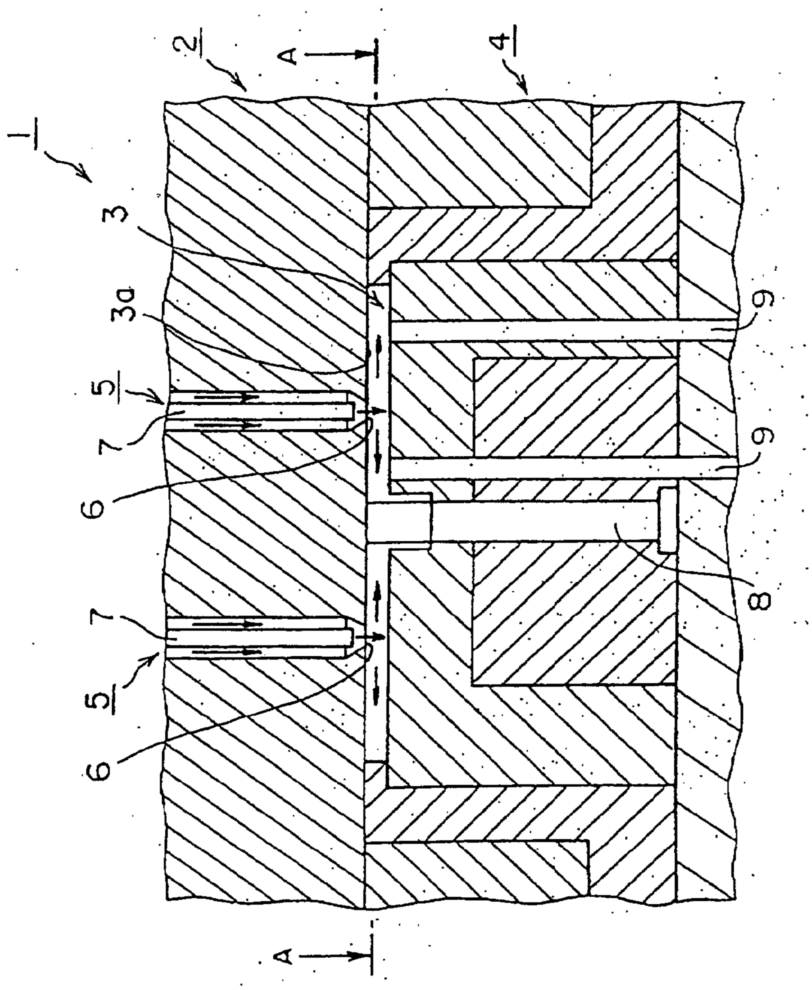

FIG. 8

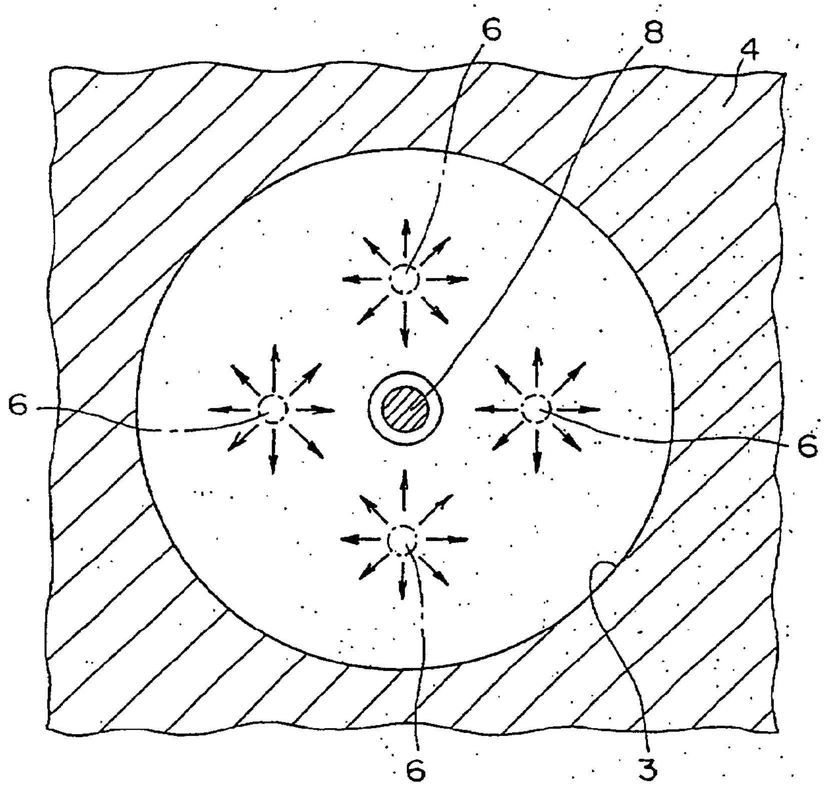

FIG. 9

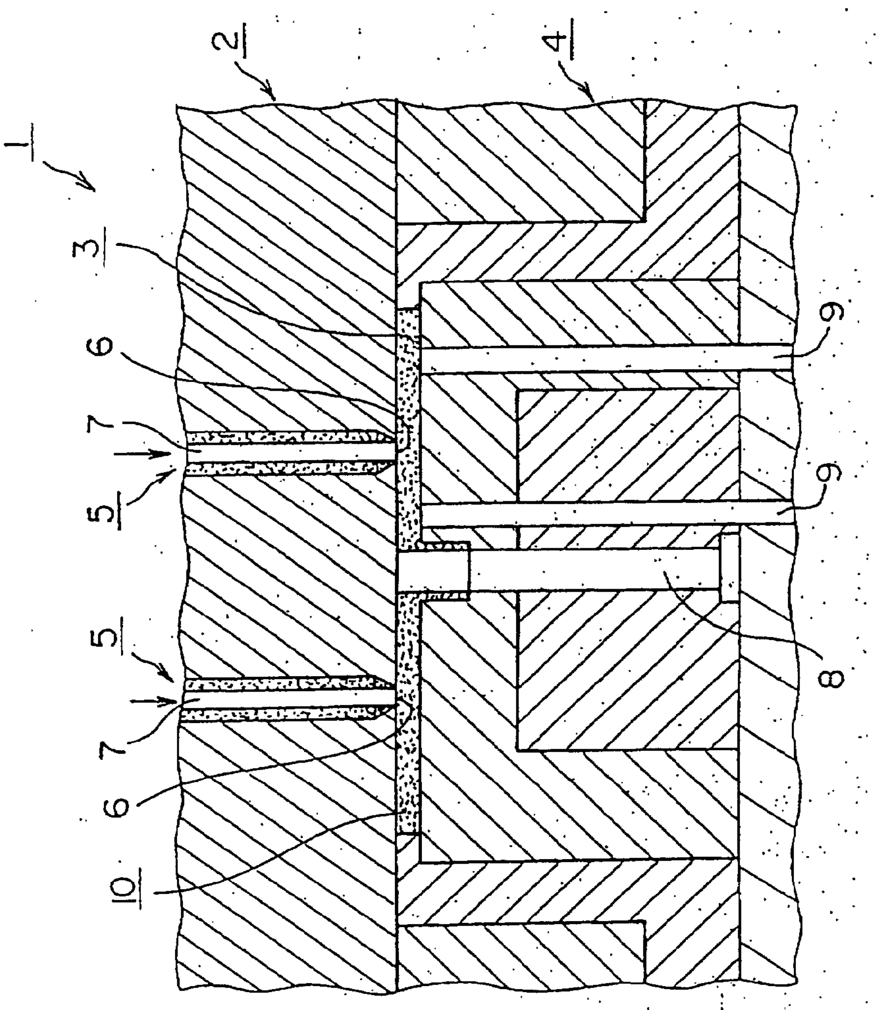

FIG. 10

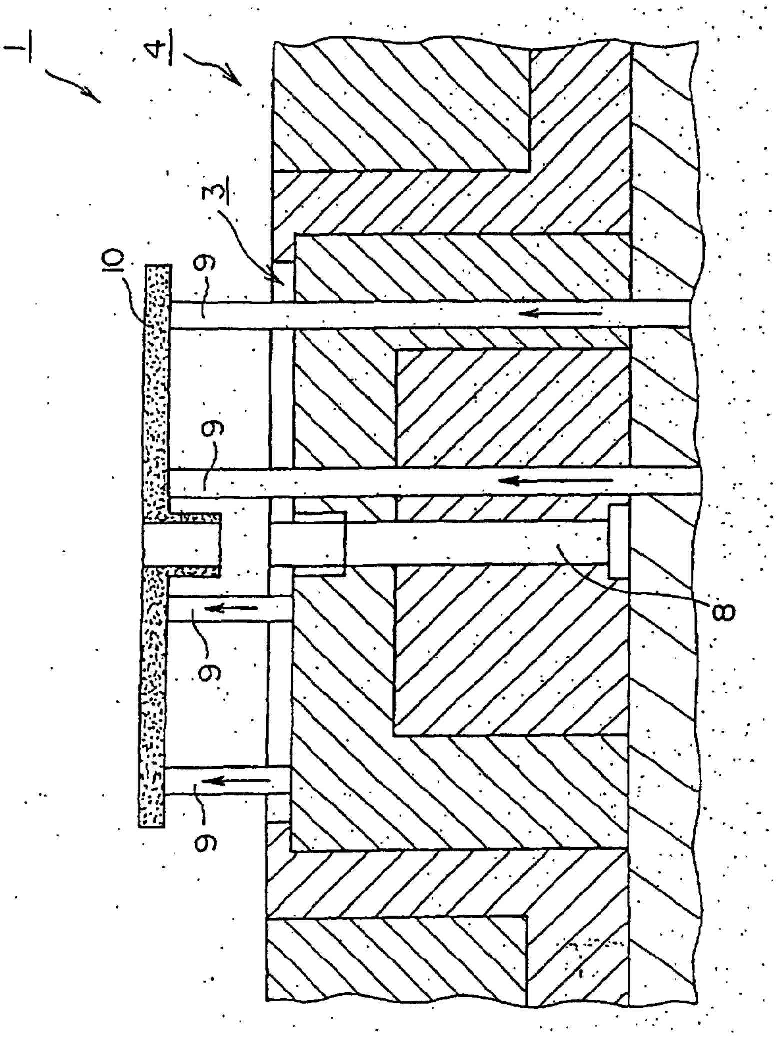

FIG. 11

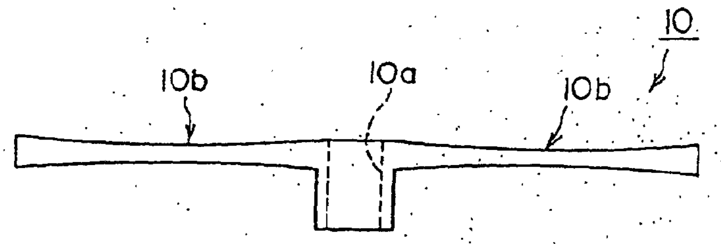

FIG. 12

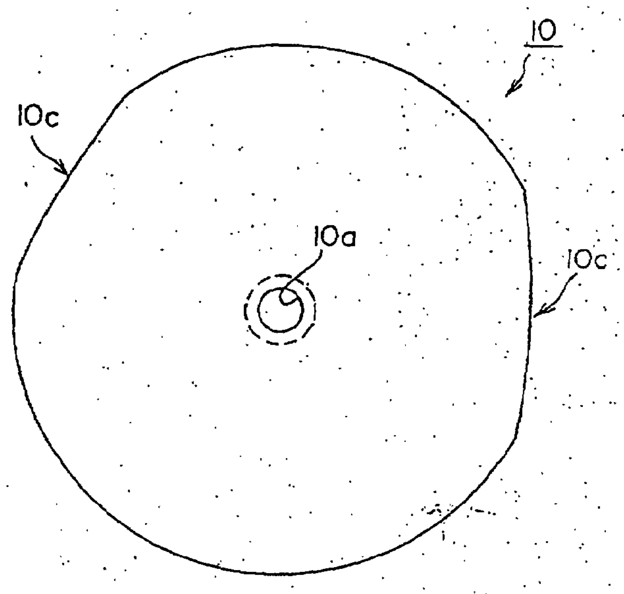

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/06540

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl7 B29C45/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl7 B29C45/26-45/44

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2000
Kokai Jitsuyo Shinan Koho	1971-2000	Jitsuyo Shinan Toroku Koho	1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, 58-131042, A (Sony Corporation), 04 August, 1983 (04.08.83), Claims; page 2, upper right column, line 10 to lower right column, line 16; drawings (Family: none)	1-4
X	JP, 8-300418, A (Ikegami Kanagata Kogyo K.K.), 19 November, 1996 (19.11.96), Claims; drawings (Family: none)	1-4
X	US, 5785915, A (JESUS M. OSUNA-DIAZ), 28 July, 1998 (28.07.98), Claims; drawings (Family: none)	1-4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search 21 November, 2000 (21.11.00)	Date of mailing of the international search report 05 December, 2000 (05.12.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)